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ICC-ES Evaluation Report
ESR-5356

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This report is subject to renewal October 2024.

DIVISION: 06 00 00—WOOD, PLASTIC, AND COMPOSITE FASTENINGS
Section: 06 11 00—Wood Framing

DIVISION: 07 00 00—THERMAL AND MOISTURE PROTECTION
Section: 07 21 00—Thermal Insulation

REPORT HOLDER:

INNOVATED STRUCTURES, INC.

EVALUATION SUBJECT:

TSTUD™ (or R19 TSTUD™) STRUCTURAL WALL STUD

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018 and 2015 *International Building Code*® (IBC)
- 2021, 2018 and 2015 *International Residential Code*® (IRC)

Properties evaluated:

- Structural

2.0 USES

The Tstud™ (or R19 Tstud™) Structural Wall Studs are structural members, where nominal 2x4 and 2x6 dimensional lumbers are specified, such as wall studs, top plates, bottom plates and headers.

3.0 DESCRIPTION

3.1 General:

The Tstud™ (or R19 Tstud™) Structural Wall Studs described in this report comply with the requirements noted in Section 2308 of the 2021, 2018 and 2015 IBC, for allowable stress design in accordance with the 2021 and 2018 IBC Section 2302.1(1) and 2015 IBC Section 2301.2(1). They may also be used in structures regulated under the IRC when an engineered design is submitted in accordance with IRC Section R301.1.3.

3.2 Material:

Tstud™ (or R19 Tstud™) Structural Wall Stud consists of two nominally 2x3 (1.5 mm by 2.5 mm actual) No. 2 Spruce Pine Fir (SPF) or 1650f–1.5E SPF lumber, $^{11}/_{16}$-inch-diameter (17.5 mm) No. 2 Spruce Pine Fir (SPF) or 1650f–1.5E SPF lumber wooden dowels and approximately 2½-inches (63.5 mm) of polyisocyanurate (polyiso) insulation, as shown in Figure x.

Tstud™ (or R19 Tstud™) Structural Wall Stud is available in 2½-inches (63.5 mm) by 5½-inches (139.7 mm). The lumber is spaced 2½-inches (50.8 mm) between members. Wooden dowels are used to connect one member to another at opposing angles, forming a web-like pattern. Dowels are spaced evenly at a distance not to exceed 6½-inches (165.1 mm) on center and glued in place using adhesive complying with ASTM D2559. Polyisocyanurate (polyiso) insulation fills the void between lumber members.

Polyisocyanurate (polyiso) insulation, described in the approved quality control manual, has a minimum density of 2.2 pcf (35.2 kg/m^3) and has flame-spread rating of 25 or less and a smoke-density rating of 450 or less when tested in accordance with ASTM E84.

4.0 DESIGN AND INSTALLATION

4.1 General:

Design and installation of Tstud™ (or R19 Tstud™) Structural Wall Stud must be in accordance with this report, the applicable code provisions and the manufacturer's published installation instructions. The manufacturer's published installation instructions must be available at the jobsite at all times during installation. The requirements specified for allowable stress design in 2021 and 2018 IBC Section 2302.1(1) and 2015 IBC Section 2301.2(1), and the design provisions for structural composite lumber in the ANSI/AWC National Design Specification (NDS) for Wood Construction, are as applicable to Tstud™ (or R19 Tstud™) Structural Wall Stud, except as modified within this report. Reference design values for Tstud™ (or R19 Tstud™) Structural Wall Stud are given in Table 1.

4.2 Wall Framing:

4.2.1 Wall Framing: Tstud™ (or R19 Tstud™) Structural Wall Studs are used as wall framing members, with fastening schedule given in Table 2.

4.2.2 Wall Plates: Tstud™ (or R19 Tstud™) Structural Wall Stud may be used as a single top plate in accordance to IRC Section R602.3.2. Fasteners for Tstud™ connections shall be distributed in each wood member, where top plate

to stud connections shall be fastened using three (3) 4-inches x 0.131-inch (101.6 mm by 3.33 mm) nails, one (1) into one wood member and two (2) into the other wood member.

4.2.3 Flat Headers: When used as flat header, fasten multi-ply Tstud™ header members using 4-inches x 0.131-inch (101.6 mm by 3.33 mm) nail at 16 inches (406.4 mm) on center.

4.2.4 Jack, Trimmer and Cripple Studs: When used as jack, trimmer and cripple studs, install cripple studs between the bottom plate and rough sill using three (3) 4-inches x 0.131-inch (101.6 mm by 3.33 mm) nails – one into one wood member and two (2) into the other wood member.

4.2.5 Sheathings: Structural sheathing shall be installed in one side of the wall and minimum ½-inch (12.7 mm) gypsum wallboard (GWB), or equivalent, on the other side of the wall fastened in accordance with the applicable building code. Sheathing attached to only one side of the wall is not permitted.

4.3 Allowable Compressive Load: For trusses and rafters placed on Tstud™ (or R19 Tstud™) Structural Wall Studs, design values can be found in Table 3.

4.4 Shear Walls: Tstud™ may be used as components within a shear walls system, provided the seismic design coefficients and factors used in design conform to the following values:

Seismic factor or Coefficient[1]	**IBC**
Response Modification Coefficient	R = 6 ½
System Over-strength factor	$\Omega_0 = 3$
Deflection Amplification Factor	$C_d = 4$
Note: [1]Where shear panels are installed in structures with flexible diaphragms, as determined in accordance with Section 12.3.1 of ASCE/SEI 7, the tabulated value of Ω_0 may be reduced in accordance with Footnote g, Table 12.2-1 of ASCE/SEI 7.	

The building height is limited to a maximum of 65 feet (19.8 m) for structures located in Seismic Design Categories D, E or F, or as limited in Tables 504.3 and 504.4 of the 2021, 2018 and 2015 IBC based on construction type.

5.0 CONDITIONS OF USE

The Tstud™ (or R19 Tstud™) Structural Wall Stud described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Fabrication, design, installation, and connection restrictions must comply with this report and the manufacturer's published installation instructions. In the event of a conflict between the manufacturer's published installation instructions and this report, this report governs.

5.2 Calculations and drawings demonstrating compliance with this report must be submitted to the code official. The calculations and drawings must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.3 Notches in structural members (2x3 or dowels) are not permitted.

5.4 Holes may only be bored in polyiso insulation of Tstud™. Holes shall be spaced a minimum of 24 inches o.c., shall be exceed 2½" (63.5 mm) in diameter and are not permitted within 24 inches from either end of the stud.

5.5 All constructions related to the use of Tstud™ (or R19 Tstud™) must follow the manufacturer's most recently published construction manual.

5.6 Tstud™ Structural Wall Stud is produced by Innovated Structures, Inc.; under a quality-control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

6.1 Data in accordance with ASTM D198, ASTM D2559, ASTM E2126 and ASTM E72.

6.2 Quality documentation in accordance with the ICC-ES Acceptance Criteria for Quality Documentation (AC10), dated May 2022.

7.0 IDENTIFICATION

7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-5356) along with the name, registered trademark, or registered logo of the report holder must be included in the product label.

7.2 The report holder's contact information is the following:

INNOVATED STRUCTURES, INC.
14048 TERRACE ROAD NE
HAM LAKE, MINNESOTA 55304
612-978-8011
www.tstud.com

TABLE 1—REFERENCE DESIGN VALUES FOR TSTUD™ (or R19 TSTUD™) STRUCTURAL WALL STUD [1,2,3,4]

GRADE	BENDING STIFFNESS		Bending[x]	Shear Force	Compression perpendicular to grain	Compression parallel to grain	Tension parallel to grain
	EI ($x10^6$ lb-in^2)	EI_{min} [x] ($x10^6$ lb-in^2)	F_bS (lb-ft)	V (lbs)	$F_{c\perp}$[x] (psi)	$F_{c\parallel}$ (psi)	F_t (psi)
No. 2 SPF	30.3	14.9	889	320	425	1,150	450
1650F_b– 1.5E	30.5	15.0	889	320	425	1,700	1,020

For **SI**: 1 psi = 6.89 kPa, 1 inch = 25.4 mm, 1 lb = 4.45 N

[1]Reference design values must be adjusted, as applicable, in accordance with Section 4.3 of NDS.

[2]Equations for various span and load conditions are available in engineering references. For example, the deflection equation for simple-supported beam under uniform load is:

$$\Delta = \frac{5.(0.7w).h^4}{384EI}$$

where:

Δ = Deflection in inches (in)
w = Uniform load in pounds per lineal foot (plf)
h = Design span in feet (ft)
EI = Bending Stiffness (lb-in^2)

[3]EI_{min} is the reference bending stiffness for beam stability and column stability calculations. For computing the column stability factor, the critical bucking design is as follows:

$$F_{cE} = \frac{\pi^2 EI_{min}}{A(I_e)^2}$$

where:

A = Minimum net section area of Tstud™ (in^2), 6.47 in^2.
l_e = Effective column length (in), K_e x h

[4]The axial compressive stress due to combined bending and axial can be computed as follows:

$$f_a = \frac{P}{A} + \frac{M}{A_m.d_{eff}}$$

where:

P = Axial load applied to Tstud™ (lbs)
A = Minimum net section area of Tstud™ (in^2), 6.47 in^2.
A_m = Minimum net section area of single Tstud™ member (in^2), 2.72 in^2.
M = Bending moment applied to Tstud™ (lb-in)
d_{eff} = Distance from center to center of Tstud™ member (in), 4.00 in.

TABLE 2—FASTENING SCHEDULE FOR TSTUD™ (or R19 TSTUD™)[1]

Application	Number & Type of Fastener	Fastener Spacing (in)	Installation
Ceiling joists to plate (toe nail)	3 (4" x 0.131")	-	Fasten two (2) toe nails into interior wood member and one (1) toe nail into exterior wood member
Rafter or roof truss to plate (toe nail)	3 (3½" x 0.135")	-	Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two (2) toe nails on one (1) side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.
	4 (4" x 0.131")		Fasten two (2) toe nails into interior wood member and two (2) toe nails into exterior wood member
Built-up studs (face nail)	(4" x 0.131")	16 o.c.	Fasten two (2) face nails, one (1) into each wood member
Abutting studs at intersection wall corner (face nail)	(4" x 0.131")	12 o.c.	Fasten one (1) face nail into exterior-facing wood member
Double 2x6 top plates (face nails)	(4" x 0.131")	12 o.c.	Fasten two (2) face nails, one (1) into each wood member
Double top plates, minimum 24" offset of end joints, face nail in lapped area	12 (4" x 0.131")	-	Fasten twelve (12) face nails on each side of end joint (minimum 24" lap splice length each side of joint)
Stud to plate (toe nail)	4 (4" x 0.131")	-	Fasten two (2) toe nails into sole plate on each side of the stud (each wood member)
Plate to stud (end nail)	3 (4" x 0.131")	-	Fasten two (2) 4" x 0.135" nails into one wood member and one (1) 4" x 0.135" nail into other wood member
	2 (4½" x 0.162")		Fasten two (2) 4½" x 0.162" nails, one (1) into each wood member
Top plates, laps at corners & intersections (face nail)	2 (4" x 0.131")	-	Fasten two (2) 4" x 0.135" face nails, one into each wood member
Rim Joist to sill or top plate	(2½" x 0.113")	4 o.c.	Fasten by toe-nailing
	(2½" x 0.131")	6 o.c.	

For **SI**: 1 inch = 25.4 mm

[1]For all connections, care must be taken to avoid splitting.

TABLE 3—ALLOWABLE COMMPRESSIVE LOADS FOR WALLS FRAMED WITH TSTUD™ (or R19 TSTUD™)[1,2,3]

STUD HEIGHT[2,3] (ft)	SPF No. 2 Tstud™				1650F_b-1.5E Tstud™			
	TOP OR BOTTOM PLATE							
	Tstud™ (SPF) (SG=0.42)[4,8]	Southern Pine (SP) (SG = 0.55) [5]	LVL[6]	LSL[7]	Tstud (SPF) (SG =0.42)[4,8]	Southern Pine (SP) (SG = 0.55) [5]	LVL[6]	LSL[7]
8	3,665	4,875	7,070	6,900	3,665	4,875	7,070	6,900
9	3,665	4,875	7,035	6,900	3,665	4,875	7,070	6,900
10	3,665	4,875	6,565	6,565	3,665	4,875	7,070	6,900
11	3,665	4,875	6,045	6,045	3,665	4,875	6,805	6,805
12	3,665	4,875	5,505	5,505	3,665	4,875	6,055	6,055
13	3,665	4,875	4,975	4,975	3,665	4,875	5,370	5,370
14	3,665	4,475	4,475	4,475	3,665	4,765	4,765	4,765
15	3,665	4,025	4,025	4,025	3,665	4,240	4,240	4,240
16	3,625	3,625	3,625	3,625	3,665	3,785	3,785	3,785

For **SI**: 1 psi = 6.89 kPa, 1 inch = 25.4 mm, 1 lb = 4.45 N

[1]The maximum allowable compression load is based on the compressive perpendicular-to-grain stress of SPF, SP, LVL or LSL top and bottom plates. Compressive perpendicular to grain stress is assumed to be 425 psi for Tstud and SPF dimensional lumber, 565 psi for SP dimensional lumber, 820 psi for LVL, and 800 psi for LSL (adjusted per NDS Section 3.10.3). Adjustment for plates having a higher or lower compressive perpendicular to grain stress is required.
[2]Maximum stud spacing of 24 inches.
[3]Maximum wall height for Tstud™ is 16 ft..
[4] Walls less than or equal to 16 feet in height are controlled by compression perpendicular to grain stress of the Tstud™ or SPF top and bottom plates..
[5]Walls less than or equal to 13 feet in height are controiled by compression perpendicular to grain stress of the SP top and bottom plates..
[6]Walls less than or equal to 10 feet in height are controlled by compression perpendicular to grain stress of the LVL top and bottom plates.
[7]Compression perpendicular to grain of the LSL top and bottom plates controls for walls less than or equal to 10 ft. in height.
[8]When Tstud™ is used as top plate, a separate means of fireblocking shall be provided in accordance with IBC Section 718 and IRC Section R302.11.

FIGURE 1 - TSTUD™ (or R19 TSTUD™) STRUCTURAL WALL STUD